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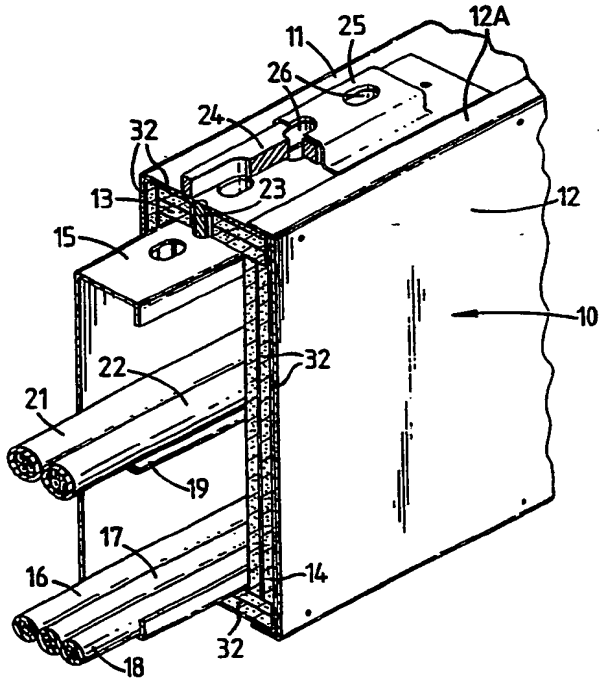

(57) Abstract

Cable trunking (10) lined with fire resistant thermal insulating material (13, 14). The trunking (10) has a panel (12) which is removable to provide access to the interior. The panel (12) has a channel section, the flanges (12A) of which form a gas-tight seal with the rest (11) of the casing. A normally-open vent arrangement (24-26) allows heat generated by the cables (16-18, 21-22) during normal operation to be dissipated. Each vent (26) is formed in a strip (24) of highly intumescent material which fills the interior of a top-hat secti n housing (25). In the event of a fire outside the trunking (10), th intumescent material within the housing (25) expands to form a rigid carbon plug which closes the respective vent (26).

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TRUNKING AND A VENTING ARRANGEMENT FOR FIRE PROTECTION STRUCTURE

DESCRIPTION

This invention relates to cable trunking for use in any one of a number of applications such as in locomotives, power stations, water or gas treatment plant, chemical process plant, oil rigs, underground railways, mines or aircraft, for cables such as power cables, control cables, data transmission cables and/or optical fibre cables. This invention also relates to a venting arrangement for fireproof structure of an enclosure whereby air can circulate through the enclosure to dissipate heat from within the enclosure or to purge the enclosure of gas.

The risk of fire and its effect gives rise for concern which should be taken into account in the design of equipment for use in the various applications identified above. This is especially so in the case of locomotives for subterranean use. Cables such as power cables, control cables, data transmission cables and/or optical fibre cables have an operating temperature which is quite low, typically less than 200°C, so that steps should be taken to protect them from the effects of fire where that is a realistic prospect. Trunking, designed to achieve that objective is known in the art as "safety critical trunking".

According to one aspect of this invention there is provided cable trunking which is lined with fire resistant thermal insulating material whereby cables

within the trunking are maintained at or below their maximum operating temperature in the vent of a fire in the surrounding environment.

There has to be provision for access to the interior of trunking, at least during installation. Preferably the trunking is provided with a removable panel lined with said fire resistant thermal insulating material on its surface which faces the interior of the trunking, the panel being removable to provide access to the interior of the trunking during its installation and for maintenance.

The insulating material may be formed from ceramic fibres, conveniently pressed into a felt form on an aluminium foil backing. Preferably the insulating material is intumescent and endothermic. For cooling purposes in the event of a fire in the surrounding environment, it is desirable to augment the endothermic properties of the insulating material by providing a fire resistant mastic material at interfaces between various components of the trunking, the mastic material having additional endothermic properties superior to that of the fibrous insulating material alone.

A preferred form of trunking in which this invention is embodied is purpose built, compact and relatively lightweight, fire-rated and insulated, providing a continuous enclosure to protect cables, such as power cables, control cables, data transmission cables or optical fibre cables as they are led through potentially hazardous environments.

Given the need to provide access to the interior of the trunking during its installation and for maintenance, the question arises of how to maintain the necessary gas-tight integrity of the trunking to prevent ingress of hot gases in the event of a fire in the surrounding environment.

Accordingly in a preferred embodiment both the removable panel and the remainder of the trunking structure are formed with a channel section, the side flanges of the panel being fitted outside the side flanges of the remainder and being sufficiently deep relative to the side flanges of the remainder to provide a gas-tight seal therebetween, the arrangement being such that, in the event of a fire within the surrounding environment, an increase in the pressure within the trunking is generated which causes doming of the main portion of the panel with the result that the side flanges of the panel are urged against the side flanges of the remainder of the trunking structure whereby to maintain the seal. The increase in pressure is caused in part by vapour released from chemically bound water within the lining of insulating material and the endothermic mastic. Other factors include the expansion of the air within the trunking and the fact that the space available for it within the trunking will be reduced by the expansion of the intumescent lining material.

Cables such as power cables, control cables, data transmission cables or optical fibre cables give off heat during operation. Thus it is desirable to ventilate the space immediately surrounding them to avoid overheating during normal operation. The need to ventilate the interior of trunking is in conflict with

the need to protect the cables from the effects of fire outside the trunking.

According to a feature of the present invention, the lined trunking is provided with normally open venting means whereby heat emitted by a cable within the trunking can be dissipated from within the trunking, there being thermally responsive means operable in the event of a fire in the surrounding environment, to close the venting means when heated to a certain temperature below the maximum operating temperature of the cable, whereby to maintain the cable at or below its maximum operating temperature. The thermally responsive means may comprise fire resistant, intumescent material which forms the perimeter of part of the or each vent and which expands to close the or each vent when subjected to said certain temperature. In the preferred embodiment this intumescent material is enclosed within a rigid housing which constrains the expansion such that the respective vent is closed, the intumescent material forming a thermally insulating rigid carbon plug. The fire resistant, thermal insulating material that forms the lining may also be intumescent, its rate of volumetric expansion being less than that of the intumescent material that expands to close the or each vent. Where there is a plurality of vents, the majority of the vents are conveniently formed in the part of the trunking that will be closest to any fire, say at the bottom of trunking which is designed to run along the top of an enclosure, the remainder being formed in the top of the trunking so as to provide air circulation and maximum ventilation in normal circumstances, but, in the event of a fire outside the trunking, to close the vents rapidly.

Conveniently the trunking has a rectangular cross-section, the removable panel being at on side, and an elongate channel section tray may be provided within the trunking along which it extends with the mouth of the channel facing the removable panel, the inner tray providing support for each cable and in turn being supported by the lining material that lines the remainder of outer casing structure of the trunking as distinct from the removable panel.

The fire resistant, intumescent material that expands to close the or each vent may be laid on the outer surface of outer casing structure of the trunking within its constraining housing, the remainder of the or each vent extending through the outer casing structure and the lining. In order to secure the inner tray within the trunking and to earth it without forming a thermal bridge between the exposed external surface of the trunking and the inner tray, and in order to minimise the use of adhesives, the inner tray is connected to the outer structure of the trunking by linking means which are joined to the outer structure trunking at a location overlaid by the fire resistant, intumescent material that expands to close a vent.

A thin layer of ceramic material may be provided between the inner tray and each cable supported by that tray whereby to insulate each cable from the tray.

The or each cable may be coated with intumescent and/or endothermic material for additional thermal insulation and fire resistance.

According to another aspect of this invention there is provided a venting arrangement for fireproof structure of an enclosure whereby air can circulate through the enclosure to dissipate heat from within the enclosure or to purge the enclosure of gas during normal operation of equipment within the enclosure, there being fire resistant intumescent material which forms the perimeter of part of the or each vent of the venting arrangement and which expands to close the or each vent when subjected to a certain temperature below the maximum operating temperature of the equipment in the event of a fire in the surrounding environment whereby to maintain the equipment at or below its maximum operating temperature, the fire resistant intumescent material that expands to close the or each vent being enclosed within a constraining housing which is secured to said fireproof structure and which defines a space which is filled by the intumescent material, the intumescent material being a material which will form a thermally insulating rigid carbon plug when expended within the constraints of said housing by being subjected to said certain temperature, that plug closing the respective vent. The carbon plug so formed is capable of withstanding a significant increase in pressure differential between the surrounding environment and the interior of the trunking.

One form of trunking in which this invention is embodied and a modification thereof will be described now by way of example with reference to the accompanying drawings, of which:-

Figure 1 is a partially cut away fragmentary view in perspective of a length of trunking with five cables extending through it;

Figure 2 is a partially cut away plan view of fragments of the trunking shown in Figure 1;

Figure 3 is a section on the line III-III in Figure 2;

Figure 4 is a partially sectioned side view of the trunking shown in Figures 1-3, the section being on the line IV-IV in Figure 3; and

Figure 5 is a section similar to Figure 3 of a modified form of the trunking.

Figures 1 and 3 show the trunking 10 is a rectangular section tube made in two parts, one part 11 being a generally C section metal outer casing portion which forms one larger side and the two shorter sides of the rectangle and two flanges which project one from each of the shorter sides at the edge thereof remote from the one larger side, toward one another in substantially the same plane, the other part 12 being a removable metal panel which is adapted to be releaseably secured by suitable fastening means to the two flanges of the C section part 11 so that the panel 12 closes the opening formed between the two flanges and completes the outer casing of the trunking. The other part 12 is also formed with a channel section. The side flanges 12A of the part 12 are fitted outside the side portions of the part 11 and are of sufficient length to provide a gas-tight seal between each of them and the respective side portion of the part 11.

The interior surface of the outer casing part 11 is lined with a mat 13 of a felt like fabric formed of compressed ceramic fibres. The face of the panel 12 which is an inner face of the trunking 10 is also lined with such a mat 14 of compressed ceramic fibres on an aluminium foil backing 14A which forms the inner surface. Thus the interior of the trunking 10 is surrounded by a tubular layer of the felt like mat of compressed ceramic fibres, that tubular layer being supported and located by the tubular metal outer casing structure 11 and 12 which it lines. The mat of compressed ceramic fibres may be formed from one of the known asbestos substitutes such as 3M Interam I10A, or Kaowool. These materials withstand high temperatures whilst also providing thermal insulation. In addition, Interam I10A has intumescent properties, typically expanding 2 or 3 times its volume when heated above 350°C. It would also be appropriate to use materials having endothermic properties which, in the event of a fire, would cause cooling of the interior of the trunking by the process of latent heat of evaporation due to their high levels of retained water of crystallisation. Interam I10A has such endothermic properties, its ingredients being Vermiculite 45-60%, Aluminium Silicate 30-45% and Acrylic Resin 6-13%.

Figures 1 and 3 show that an inner channel section tray 15 is supported on the compressed ceramic fibre mat material that lines the inner surface of the C section outer casing part 11. The inner tray 15 which is formed of a high temperature fire-resistant plastics material, supports three cables 16-18 side by side on its lower inner surface and has an integral shelf element 19 extending parallel to its top and

bottom surfaces intermediate those surfaces on which two more cables 21 and 22 are supported. The inner tray 15 is supported from the top and bottom portions of the C section outer casing part 11 which form the two shorter sides of the rectangle casing, by spaced ties 23 which are each secured by one end to the tray 15 and by their other end to the metal out casing part 11. A strip 24 of another intumescent material is laid over the junctions of each tie 23 with the metal out casing part 11. That strip 24 is held in place by a top hat section cover 25 which extends over that strip 24 and is secured to the metal out casing part 11 by its flanges. The space contained within the top hat section 25 that is closed by the metal out casing part 11 is filled with the strip 24 of intumescent material. The intumescent material chosen has a higher rate of volumetric expansion than does the intumescent material employed to line the outer casing structure of the trunking 10 and expands at a lower temperature than does that lining material, say at a temperature of the order of 175-200°C. Suitable material includes 3M CP-25 mastic (ingredients heat resistant plasticized rubber resin 66-79%, 2-Butanone 10-15%, Xylene 10-15%, Amorphous Silica 1-4%, and Iron Oxide 1-4%), 3M CP-25 WB waterbased mastic, and 3M FS195 intumescent strip material (ingredients synthetic rubber, silicate salts, synthetic resin, acrylic adhesive (all bound) and paper liner 75-92%, crystalline silica (bound) 8-10%, Di(2-ethylhexyl) phthalate (bound) 8-10% and lead tetroxide (bound) 2%).

Vents 26 are formed at spaced locations in the top and bottom walls of the lined trunking 10, each of those vents 26 extending through the lining 13, the metal

outer casing part 11, the strip 24 of intumescent material and the top hat section 25. These vents 26 allow heat given off by the cables 16-18, 21 and 22 within the trunking 10 to be dissipated so that the risk of heat build up within the trunking 10 is reduced.

In the event of a fire, the strip 24 of intumescent material will expand when the surrounding temperature rises to a temperature of the order of 175-200°C. Due to its high rate of volumetric expansion, the intumescent material of the strip 24, being constrained by the structure of the top hat section 25, expands to form a rigid carbon plug which closes the respective vent 26 through it and thereby to substantially completely enclose the interior of the trunking 10 with fire resistant, thermal insulating material so that the cables 16-18, 21 and 22 within that trunking 10 are protected from the full effects of the fire.

There will be an increase in pressure within the trunking. That pressure increase is caused in part by vapour released from chemically bound water within the lining of intumescent material 13,14. That increase in pressure within the trunking causes outwards doming of the main portion of the panel 12 with the result that the side flanges 12A of the panel 12 are urged against the side flanges of the casing part 11 whereby to maintain the gas tight seal against ingress of hot gases from the fire to the interior of the trunking.

The majority of the vents 26 will be formed in the bottom surface of the trunking 10, where their effectiveness will be optimised because they will be

closer to the fire. The remainder are formed in the top of the trunking 10 so that they will respond to the resultant hot air that will rise and so that there will be a through draft whereby air circulation through the trunking will be encouraged. The spacing of the vents 26 at the top and at the bottom is chosen in accordance with the thermal loading generated by the heat output of the cables 16-18.

The expansion of the inner lining material 13 and 14 on the removable panel 12 will cause that material to expand inwardly into intimate contact with the cables 16-18, 21 and 22 so as to provide additional protection for the cables 16-18, 21 and 22. As a result the volume of the interior of the trunking would be reduced which is another factor contributing to the increase in pressure within the trunking which caused doming of the removable panel. The thickness of the ceramic material could be increased to provide increased and/or longer lasting thermal insulation and fire protection. The surfaces of the inner tray 15, including its shelf 19, are conveniently lined with a layer of ceramic material whereby to provide further insulation from the cables 16-18, 21 and 22 between them and the inner tray 19. The cables 16-18, 21 and 22 themselves may be coated with a layer of intumescent and/or endothermic material to provide them with further insulation and fire resistance.

The inner tray 15 may be omitted as shown in Figure 5. This has the advantage of reducing weight and facilitates application of the invention to complex trunking shapes. The inner surfaces of the lining 13A and 14A are formed by aluminium foil backing sheets. Cables 16,17 and 18 run along the bottom of the

interior of the trunking, resting on the aluminium foil. The interior of the trunking is divided into separate compartments by respective perforated barriers of which a typical one is shown at 19A. Each barrier 19A is mounted on the casing part 11 by a respective ceramic stand-off spacer 31 to which it is fixed by a screw 30. Each spacer 31 is secured to the inner wall of the outer casing part 11 by a fire rated adhesive or is fixed by suitable mechanical means. Cables 21 and 22, run one on each perforated barrier 19A. It is desirable to augment the endothermic properties of the lining material forming the lining 13,14. To that end a fire resistant mastic material 32 is provided at interfaces between the various component parts of the trunking as can be seen from Figure 5. The mastic material which conveniently may be 3M Firedam 150 Caulk endothermic mastic material (ingredients aluminium hydroxide 60-90% and reinforced heat resistant polymer resin 7-35%) has additional endothermic properties superior to that of the material which forms the lining 13,14.

Figures 3 and 5 both show the trunking provided with wall or floor mountings (33).

Earthing connections between internal structure and the outer casing are provided as necessary. Where possible such earthing connections are connected to portions of the outer casing which are covered by strips 24. However in certain situations, such earthing connections are through the ceramic stand-off spaces 31, but these are kept to a minimum.

The design is fully compatible with standard lectro-magnetic shielding t chniques. Specifically this comprises the combination of the perforated barriers 19 which are formed of metal and which divide the interior of the trunking into compartments, and the aluminium foil 13A,14A which forms the inner surfaces of the trunking and which is electrically conductive.

CLAIMS

1. Cable trunking characterised in that it is lined with fire resistant thermal insulating material whereby cables within the trunking are maintained at or below their operating temperature in the event of a fire in the surrounding environment.

2. Cable trunking according to claim 1, provided with a removable panel lined with said fire resistant thermal insulating material on its surface which faces the interior of the trunking, the panel being removable to provide access to the interior of the trunking, during its installation and for maintenance.

3. Cable trunking according to claim 1 or claim 2, wherein the insulating material is formed form ceramic fibres.

4. Cable trunking according to claim 3, wherein the ceramic fibres are pressed into a felt form on an aluminium foil backing.

5. Cable trunking according to any one of claims 1 to 4, wherein the insulating material is intumescent.

6. Cable trunking according to any one of claims 1 to 5, wherein the insulating material is endothermic.

7. Cable trunking according to any one of claims 1 to 6, provided with a fire resistant mastic material at

interfac s between various components of the trunking.

8. Cable trunking according to claim 7, wherein the endothermic properties of the mastic material are superior to that of the fibrous insulating material.

9. Cable trunking according to claim 2 or any one of claims 3 to 8 when appended to claim 2, wherein both the removable panel and the remainder of the trunking structure are formed with a channel section, the side flanges of the panel being fitted outside the side flanges of the remainder and being sufficiently deep relative to the side flanges of the remainder to provide a gas-tight seal therebetween, the arrangement being such that in the event of a fire within the surrounding environment an increase in the pressure within the trunking causes doming of the main portion of the panel with the result that the side flanges of the panel are urged against the side flanges of the remainder of the trunking structure whereby to maintain the pressure-tight seal.

10. Cable trunking according to any one of claims 1 to 9, provided with normally-open venting means whereby heat emitted by a cable within the trunking can dissipate from within the trunking, there being thermally responsive means operable in the event of a fire in the surrounding environment, to close the venting means when heated to a certain temperature below the maximum operating temperature of the cable, whereby to maintain the cable at or below its maximum operating temperature.

11. Cable trunking according to claim 10, herein the thermally responsive means comprise fire resistant intumescent material which forms the perimeter of part of the or each vent of the venting means and which expands to close the or each vent when subjected to said certain temperature.

12. Cable trunking according to claim 11 wherein the fire resistant intumescent material which forms the perimeter of part of the vent is enclosed within a respective rigid housing which constrains its expansion such that the respective vent is closed, the intumescent material forming a thermally insulating rigid carbon plug which closes the respective vent.

13. Cable trunking according to either of claims 11 and 12 when appended to claim 5, wherein the rate of volumetric expansion of the fire resistant thermal insulating material that forms the lining is less than that of the intumescent insulating material that expands to close the or each vent.

14. Cable trunking according to any one of claims 10 to 13 having a plurality of vents, wherein the majority of the vents is formed in the part of the trunking that will be closest to any fire when the trunking is installed.

15. Carble trunking according to claim 14 designed to be installed so as to run along the top of an enclosure, wherein the majority of the vents are at the bottom of the trunking, the remainder being formed in the top of the trunking so as to provide air circulation and to maximise ventilation in normal

circumstances, but, in the event of a fire outside the trunking, to close the vents rapidly.

16. Cable trunking according to claim 2, claim 9 or any one of claims 3 to 8 and 10 to 15 when appended to claim 2, having a rectangular section, the removable panel being at one side, and an elongate channel section tray being provided within the trunking along which it extends with the mouth of the channel facing the removable panel, the inner tray providing support for each cable and in turn being supported by the lining material that lines the remainder of the outer casing structure of the trunking as distinct from the removable panel.

17. Cable trunking according to claim 12, claim 13 or any one of claims 14 to 16 when appended to claim 12, wherein the fire resistant intumescent material that expands to close the or each vent is laid on the outer surface of the outer casing structure of the trunking within its constraining housing, the remainder of the or each vent extending through the outer casing structure and the lining in line with the part of the outer layer of intumescent thermal insulating material.

18. Cable trunking according to claim 17 when appended to claim 16, wherein the inner tray is connected to the outer structure of the trunking by linking means which are joined to the outer structure of the trunking at a location overlaid by the fire resistant intumescent material that expands to close a vent.

19. Cable trunking according to any one of claims 16 to 18, wherein a thin layer of ceramic material is provided between the inner tray and each cable supported by that tray whereby to insulate each cable from the tray.

20. Trunking according to any one of claims 1 to 19, wherein the or each cable led through the trunking is coated with intumescent and/or endothermic material for additional insulaion and fire protection.

21. A venting arrangement for fireproof structure of an enclosure whereby air can circulate through the enclosure to dissipate heat from within the enclosure or to purge the enclosure of gas during normal operation of equipment within the enclosure there being fire resistant intumescent material which forms the perimeter of part of the or each vent of the venting arrangement and which expands to close the or each vent when subjected to a certain temperature below the maximum operating temperature of the equipment in the event of a fire in the surrounding environment whereby to maintain the equipment at or below its maximum operating temperature, the fire resistant intumescent material that expands to close the or each vent being enclosed within a constraining housing which is secured to said fireproof structure and which defines a space which is filled by the intumescent material, characterised in that the intumescent material is a material which will form a thermally insulating rigid carbon plug when expanded within the constraints of said housing by being subjected to said certain temperature, that plug closing the respective vent.

FIG. 1

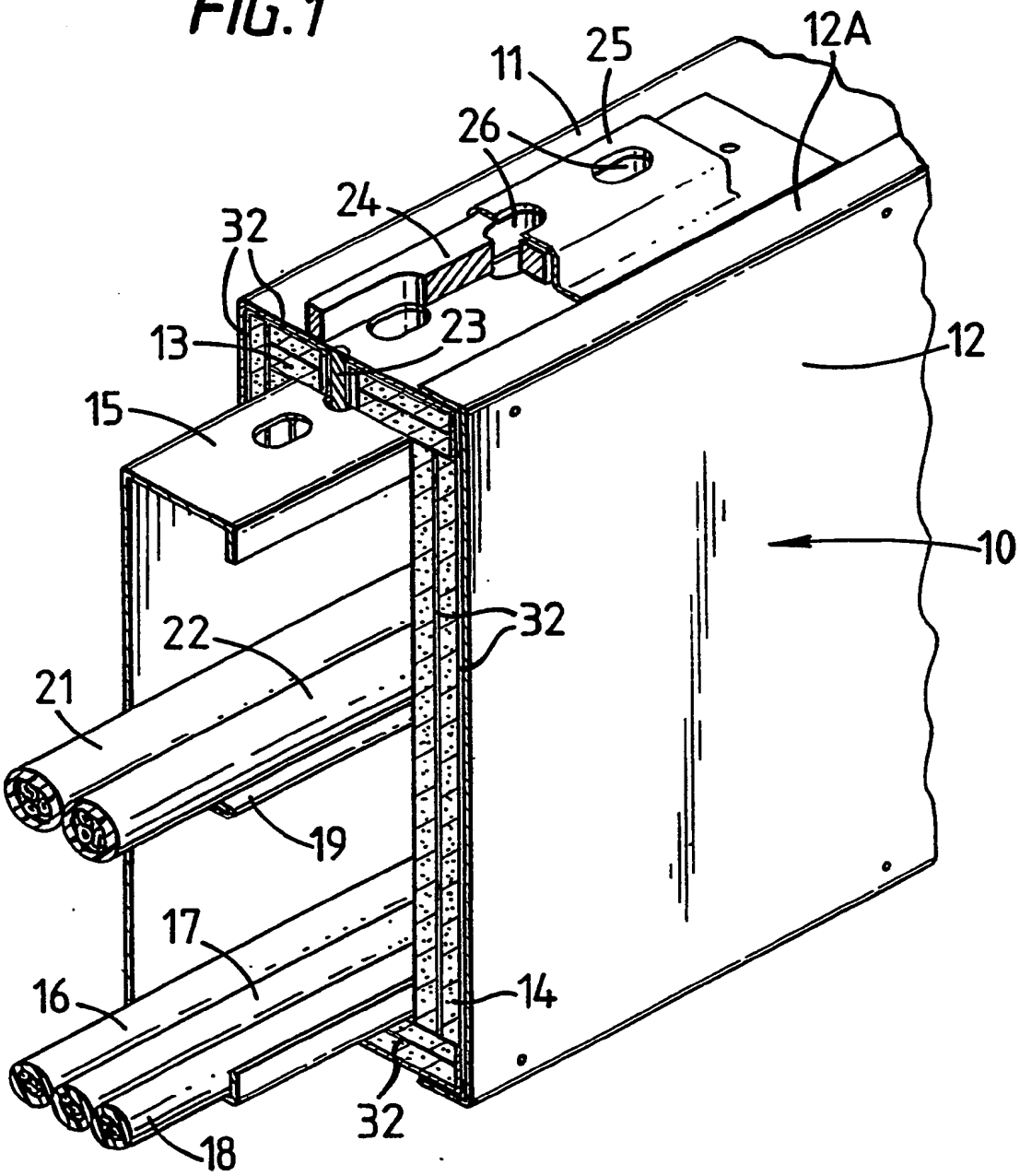


FIG.2

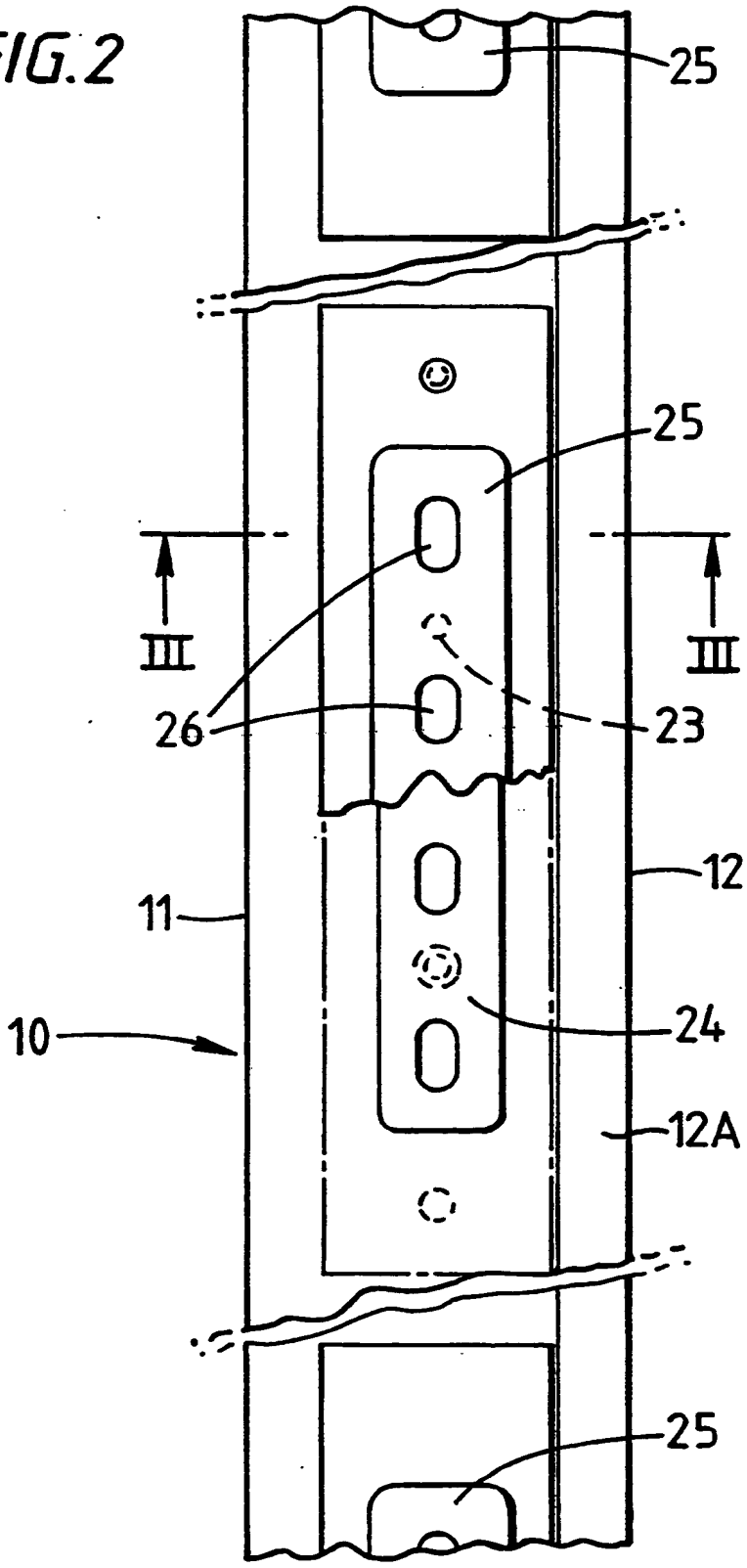
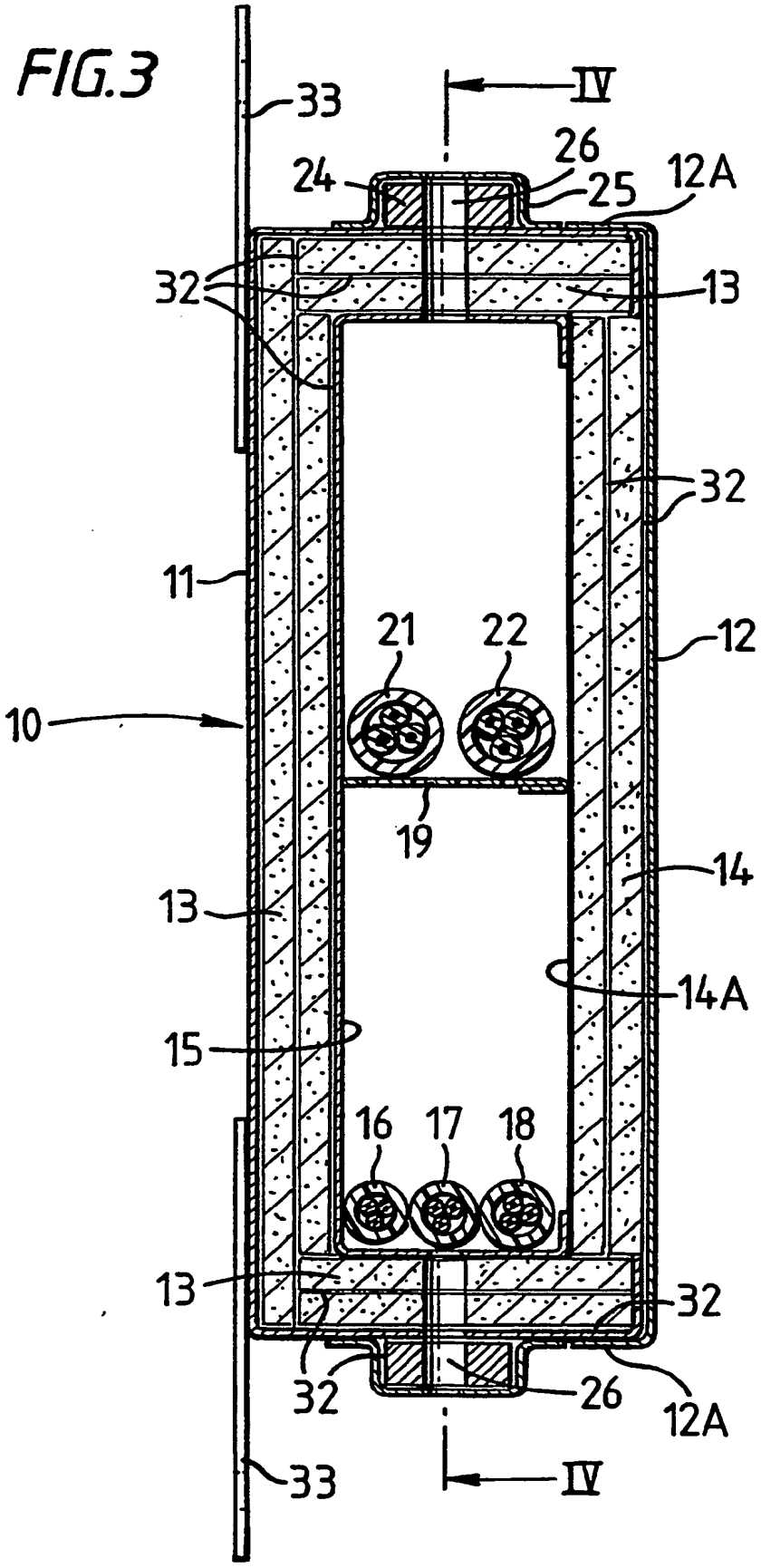


FIG.3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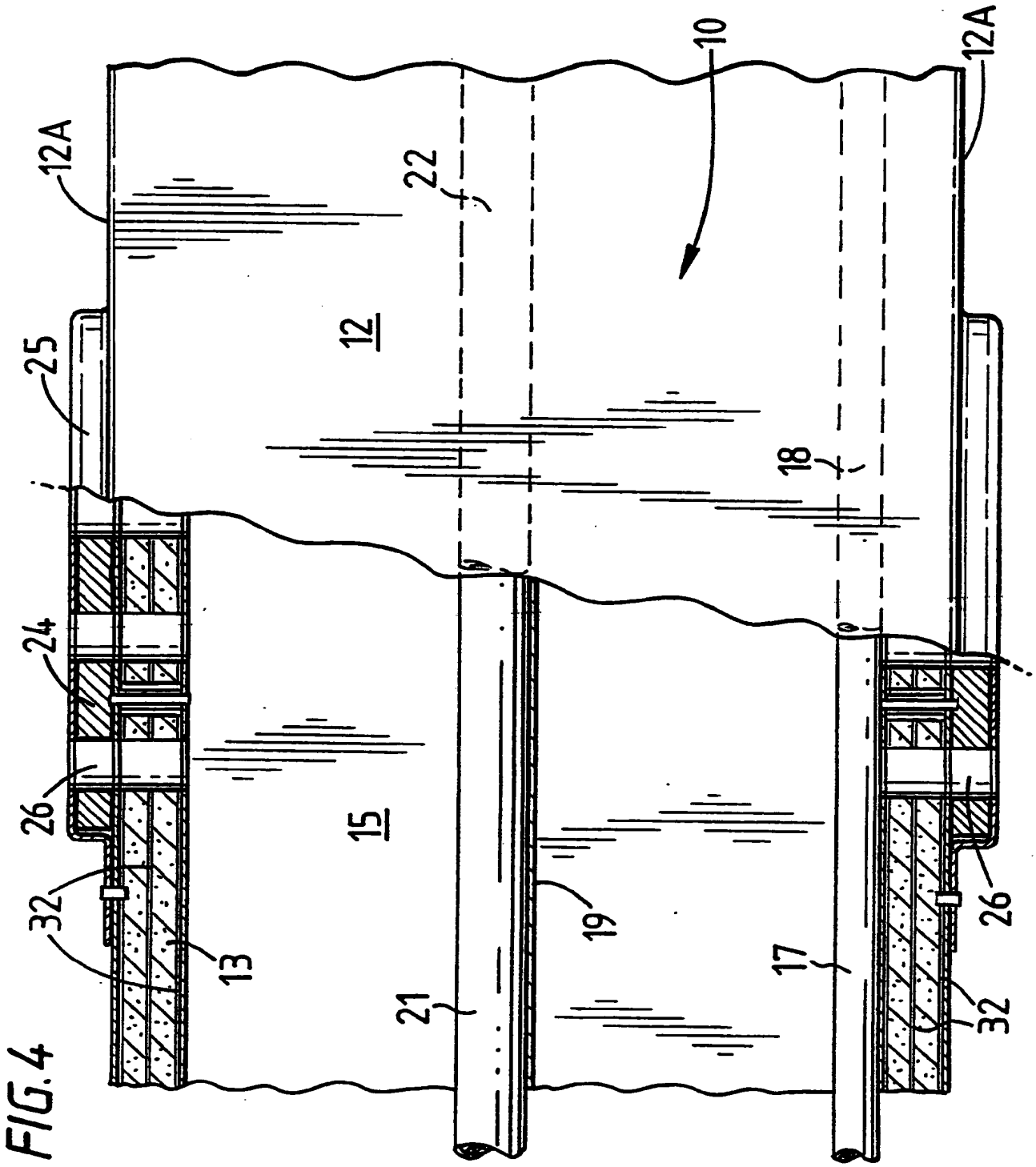
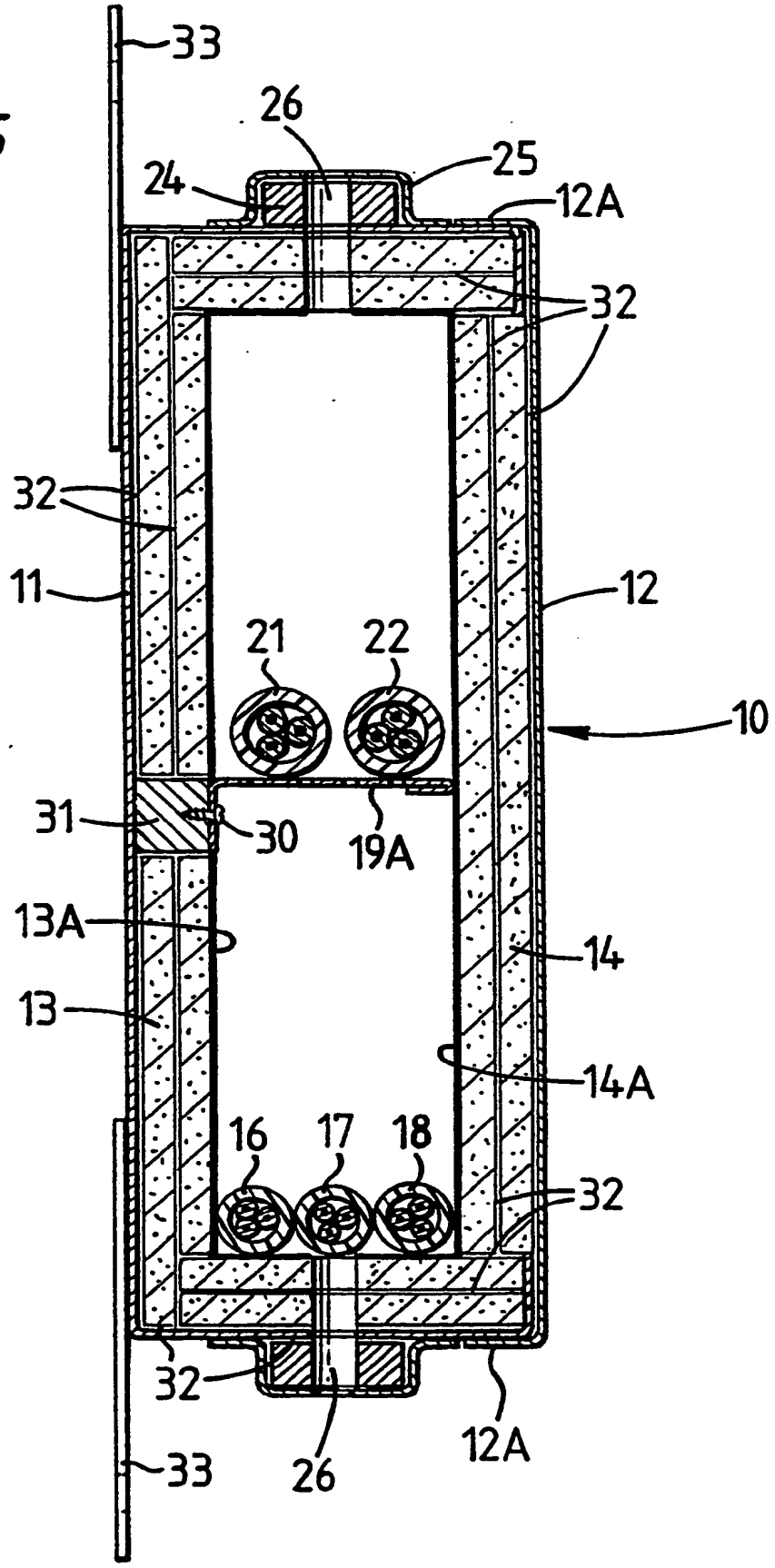


FIG.4

FIG.5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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00876

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H02G3/04; A62C2/06

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H02G ; A62C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	DE,U,8 509 123 (WOLTERS KG BRANDSCHUTZTECHNIK) 13 June 1985	1,2,10, 11
A	see page 6, line 4 - page 7, line 7; figures 1,2	12,21
X	DE,A,3 509 729 (LUDWIG SCHEER GMBH) 2 October 1986	1,10,11
A	see page 8, paragraph 5 - page 10, paragraph 1; figure 1	12,21
X	FR,A,2 435 844 (GRAEPEL) 4 April 1980	1,5
A	see page 1, line 28 - page 2, line 34; figure 1	10,11,21

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° Special categories of cited documents : [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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International Searching Authority	**Signature of Authorized Officer**
EUR PEAN PATENT OFFICE	BOLDER G.

Form PCT/ISA/21 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	EP,A,0 476 945 (ENVIRONMENTAL SEALS LIMITED) 25 March 1992 see column 2, line 33 - column 2, line 54; figure 2	1,3,5
A	GB,A,1 575 308 (ADVANCED FIREPROOFING SYSTEMS LIMITED) 17 September 1980 see page 1, line 28 - page 1, line 36; figure 2	1,3,20

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82